

# REPORT DOCUMENTATION PAGE

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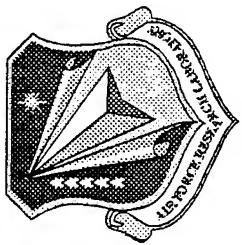
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## MEMORANDUM FOR IN-HOUSE PUBLICATIONS

FROM: PROI (TI) (STINFO)

30 Apr 98

SUBJECT: Authorization for Release of Technical Information, Control Number: AFRL-PR-ED-TP-1998-089  
Pat Carrick "New Propellants and Propulsion Techniques" HEDM Presentation (Statement A)

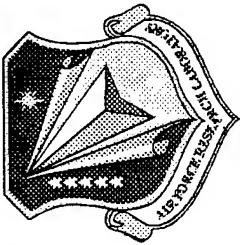


# New Propellants and Propulsion Techniques

Dr Patrick Carrick  
Air Force Research Laboratory  
Propulsion Sciences and  
Advanced Concepts Division  
Edwards AFB, CA

# Outline

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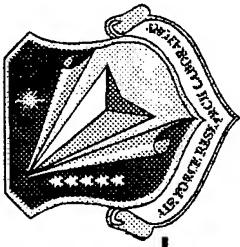


## High Energy Density Matter (HEDM)

- Energetic liquid hydrocarbon fuels
- Non-toxic liquid monopropellants
- Cryogenic solid propellants
- Theory development & calculations

## Laser Propelled Lightcraft

# Concepts Examined



**Chemically Bound Excited States**

**High Spin States**

**Dications**

**Ionic Hydrogen Clusters**

Too reactive or unstable;  
no good stabilization method

**Unique Inorganic Molecular Systems**

**Strained Ring Systems**

**Small Molecules**

High payoff areas  
for energetics;  
heteroatom systems  
of particular interest

Enables use of highly  
energetic systems

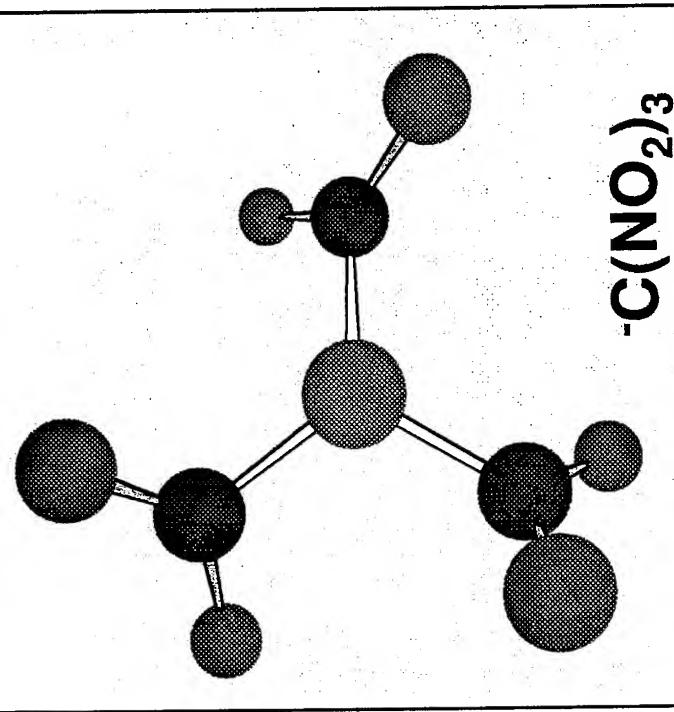


# Solid Hydrogen Additives

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- Demonstrated trapping of Li, B, N, O, Mg, and Al atoms in solid H<sub>2</sub> at ~0.1% concentrations
- Samples are stable at liquid helium temperatures
- Do not fully understand microscopic structures/dynamics
- Need to increase concentrations and sample sizes (recently scaled up from ~10µm to 1cm H<sub>2</sub> matrices)

# Advanced Monopropellants



Candidate propellants	Isp (sec)*	$\rho \text{ (g/cc)}$
- Hydrazine	198	1.00
- Peroxide	164	1.43
- RKS-M1	270	1.69

\*  $P_c=1000 \text{ psi}$ , Sea Level exhaust

## Approach

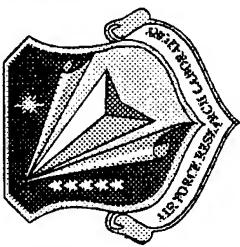
- Low melting salts, dissolved in solvents
- Low volatility
- Low toxicity
- Solvents act as fuel, tailor properties
- Low shock sensitivity

## Payoff

- Up to 130% Isp\* Density Increase
- Double Satellite On-orbit Lifetime
- Non-toxic hydrazine replacement

## Status

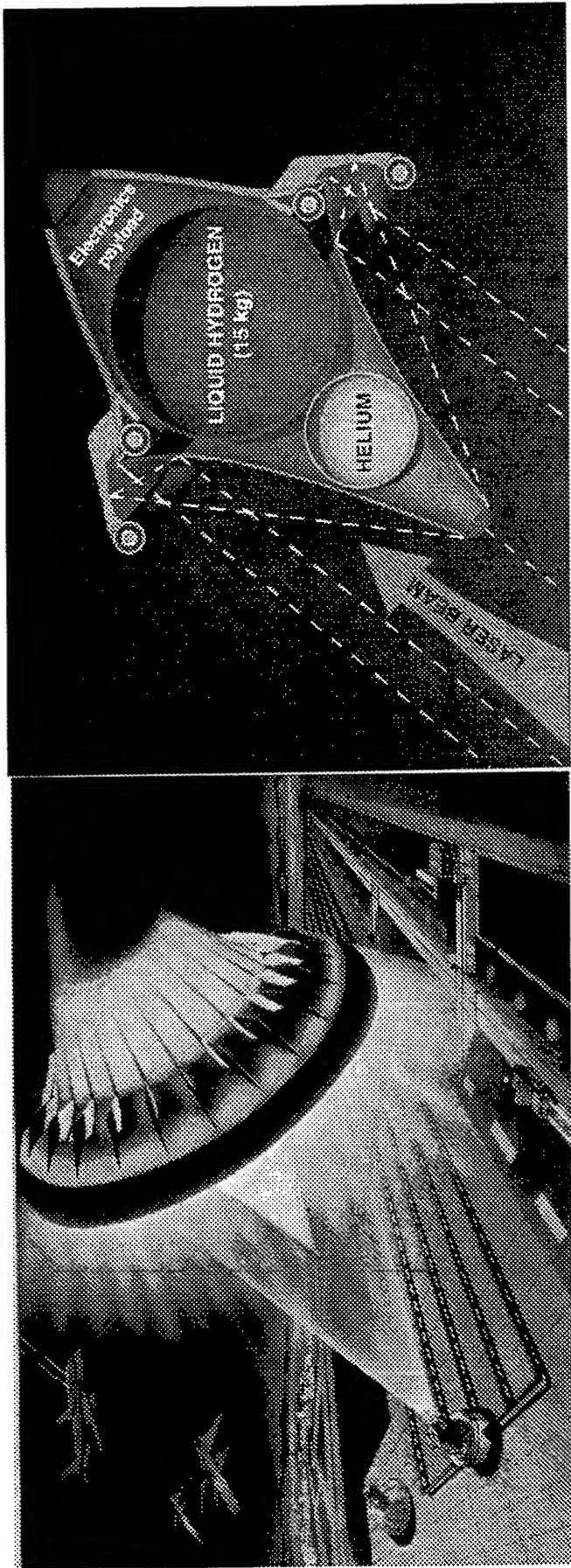
- Several candidates synthesized
- One has low shock sensitivity
- Low cost synthesis established



# What is Lightcraft Technology?

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## Laser Propelled Launch Vehicle



### What it will look like:

- Ground-based Laser
- Pulsed Laser Propulsion

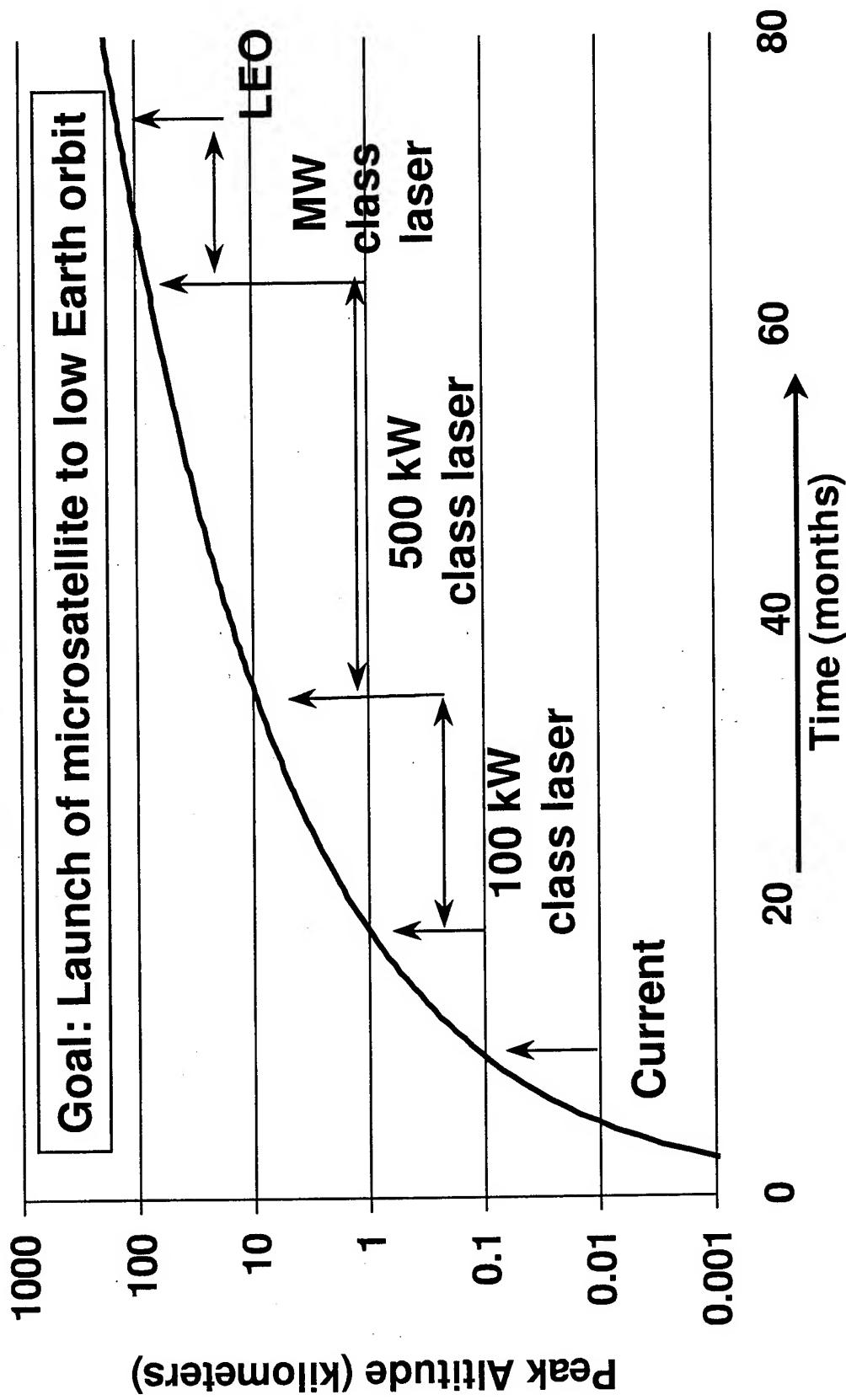
### How it will work:

- Air breathing to 30km
- Rocket propelled to orbit

# Lightcraft Technology

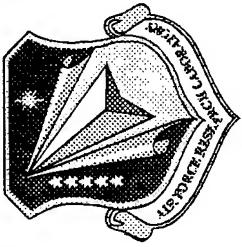


## Schedule



# **Technology Assessment**

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## ***Lightcraft Propulsion***

**Vertical flights, up to  
100 miles altitude,  
air-breathing only**

**Launch of up to  
5 kg into Low Earth  
Orbit (200 nm)**

**Launch of up to  
100 kg into LEO;  
interstellar flights**

### **Approximate Milestone Targets**

**Near Term  
(2 - 5 years)**

**Mid Term  
(5 - 10 years)**

**Far Term  
(20-50 years)**

**Laser Power Required to Achieve Goal**

**100 - 500 kW**

**2 - 5 MW**

**100-500 MW**